

What is claimed is:

1. An apparatus comprising:
  - an ion source for repetitively generating ions;
  - an ion-fragmentation device fluidly coupled to said ion source;
  - an ion extractor, fluidly coupled to said ion fragmentation device and extracting said ions;
  - a time-of-flight mass spectrometer fluidly coupled to and accepting ions from said ion extractor,
  - a position sensitive ion detector fluidly coupled to said time-of-flight mass spectrometer to detect said ions;
  - a timing controller in electronic communication with said ion source and said ion extractor said timing controller tracking and controlling the time of activation of said ion source and activating said ion extractor according to a predetermined sequence; and,
  - a data processing unit for analyzing and presenting data said data processing unit in electronic communication with said ion source, said ion extractor, and said position sensitive ion detector.
2. The apparatus according to claim 1 wherein the ion fragmentation device is positioned to fragment ions at a location within the ion extractor or at a location before the ion extractor.
3. The apparatus according to claim 1 wherein said timing controller or said data processing unit or both are in electronic communication with said ion-fragmentation device.
4. A method of determining the temporal profile of fast ion processes comprising:
  - generating ions in an ion source;
  - tracking the time of said step of generating by a timing controller;
  - fragmenting said ions to form fragment ions;

extracting said ions and fragment ions in a single or repetitive manner according to a predetermined sequence;

separating said extracted ions and fragment ions in a time-of-flight mass spectrometer;

detecting said ions and fragment ions with a position sensitive ion detector capable of resolving the location of impact of said ions and fragment ions onto said detector;

analyzing the time characteristics of said fast processes from said impact location, the time from the step of tracking, and the time of activation of said extractor to determine the temporal profile of the fast ion processes.

5. The method of claim 4 wherein the step of fragmenting said ions occurs in the ion extractor or upstream of the ion extractor.

6. The method of claim 4 wherein the step of analyzing further comprises analyzing the time characteristics of said fast processes using the time of activation of said step of fragmenting.

7. An apparatus comprising:

an ion source capable of repetitively generating ions;

an ion-fragmentation device fluidly coupled to the ion source and capable of generating fragment ions;

an ion extractor, fluidly coupled to the ion-fragmentation device and extracting said ions and fragment ions;

a time-of-flight mass spectrometer fluidly coupled to and accepting said ions and fragment ions from said ion extractor,

an ion detector fluidly coupled to said time-of-flight mass spectrometer to detect said ions and fragment ions; and,

a timing controller in electronic communication with said ion source and said ion extractor said timing controller tracking and controlling the time of activation of said ion source and activating said ion extractor according to a predetermined sequence said sequence having a time offset between the activation of said ion source and the activation of said ion extractor.

8. The apparatus according to Claim 7 wherein the ion fragmentation device is positioned to fragment ions at a location within the ion extractor or at a location before the ion extractor.
9. The apparatus according to Claim 7 wherein said timing controller is in electronic communication with said ion-fragmentation device.
10. A method of determining the temporal profile of fast ion processes comprising:
  - generating ions from an ion source;
  - extracting said ions in a single or repetitive manner;
  - activating said step of generating ions and said step of extracting said ions by a timing controller wherein said timing controller operates according to a predetermined sequence and further wherein said timing controller operates by a time offset between said step of activating and said step of extracting;
  - fragmenting said ions before they are extracted into the time-of-flight mass spectrometer
  - separating the ions and fragment ions according to their time-of-flight in a time-of-flight mass spectrometer;
  - detecting the mass separated ions and fragment ions;
  - analyzing the time characteristics of said fast ion processes from the time of said steps of activating, extracting, and detecting to determine the temporal profile of the fast ion processes.
11. The method of claim 10 wherein the step of fragmenting said ions occurs in the ion extractor or upstream of the ion extractor.
12. The method of claim 10 wherein the step of analyzing further comprises analyzing the time characteristics of said fast processes using the time of activation of said step of fragmenting.